

#### LA-UR-19-24541

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Pit and Crack Detection Summary Report FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a\_cTOP10 Title:

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Intended for: Report

Issued: 2019-05-16



## Pit and Crack Detection Summary Report FY16\_DE05\_SW\_C2\_Zone 12\_Section\_a\_cTOP10

James G. Wendelberger

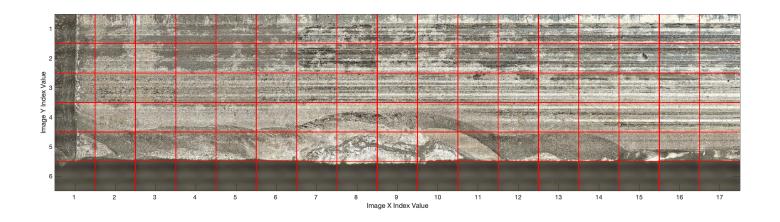
CCS-6

10-May-2019

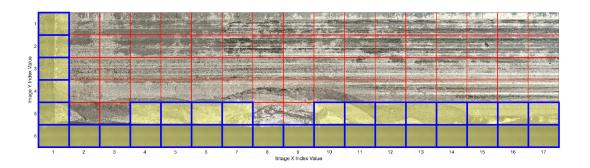
### Laser Confocal Microscope Visual Image FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a\_cTOP10



### Visual Image with Image Grid Overlay Y Downward 1:6 & X Rightward 1:17



### Visual Image with Image Grid Overlay Yellow Shaded Image(s) Excluded



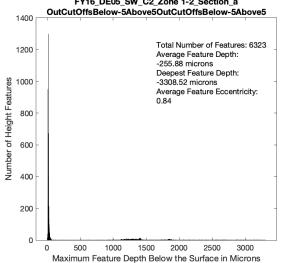
### Height Data - Summary for All Images FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a\_cTOP10

#### Pit Depth YX Index Key

## Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a | Deepest Pit in Each Image of FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a |

#### Pit Depth Histogram - All Images

Height Flagged Features from All Images Maximum Depth in Microns Below the Surface FY16 DE05 SW C2 Zone 1-2 Section a

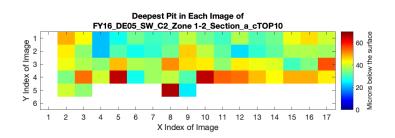


Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000

Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

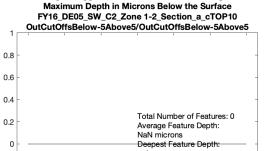
### Height Data - Summary Selected Images FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a\_cTOP10

#### Pit Depth YX Index Key



#### **Pit Depth Histogram - Selected Images**

**Height Flagged Features from Selected Images** 



Average Feature Eccentricity:

Maximum Feature Depth Below the Surface in Microns
Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

5/15/19 6

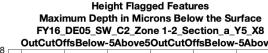
of Height Features

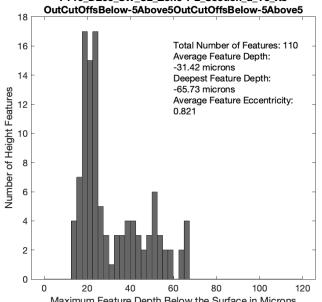
-0.2

-0.4

-0.6

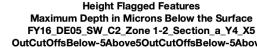
### Pit Depth Y5X8 Histogram Height Data Deepest Pit Ranking: 1

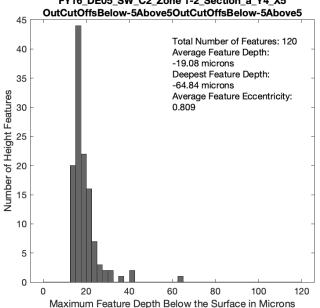




Maximum Feature Depth Below the Surface in Microns
Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

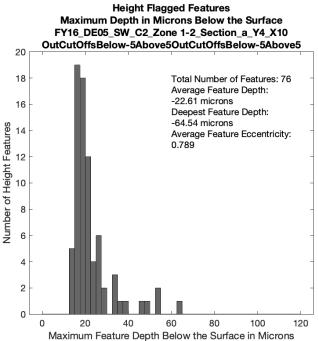
### Pit Depth Y4X5 Histogram Height Data Deepest Pit Ranking: 2





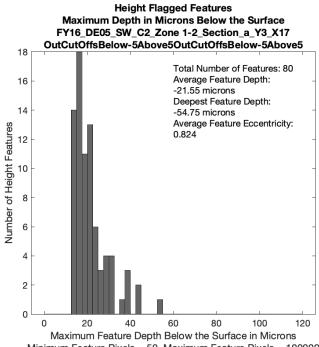
Maximum Feature Depth Below the Surface in Microns
Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

### Pit Depth Y4X10 Histogram Height Data Deepest Pit Ranking: 3



Maximum Feature Depth Below the Surface in Microns
Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

### Pit Depth Y3X17 Histogram Height Data Deepest Pit Ranking: 4

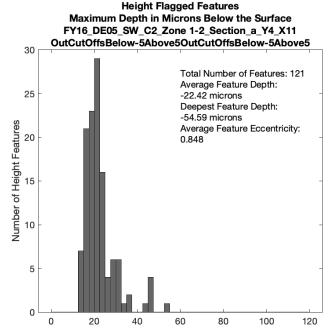


Maximum Feature Depth Below the Surface in Microns

Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000

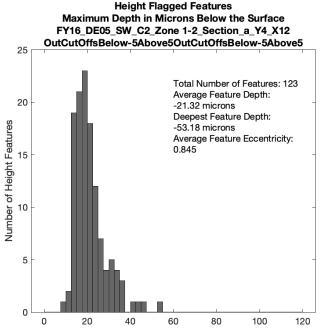
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

### Pit Depth Y4X11 Histogram Height Data Deepest Pit Ranking: 5



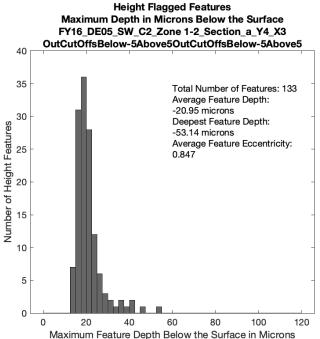
Maximum Feature Depth Below the Surface in Microns
Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

### Pit Depth Y4X12 Histogram Height Data Deepest Pit Ranking: 6



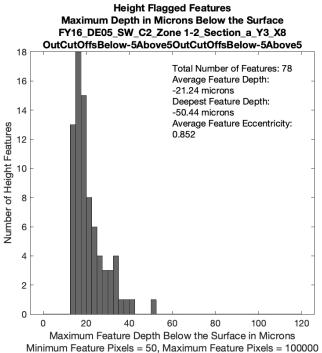
Maximum Feature Depth Below the Surface in Microns
Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

### Pit Depth Y4X3 Histogram Height Data Deepest Pit Ranking: 7



Maximum Feature Depth Below the Surface in Microns
Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

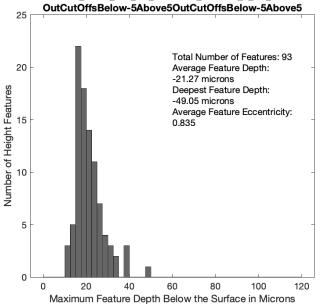
### Pit Depth Y3X8 Histogram Height Data Deepest Pit Ranking: 8



Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

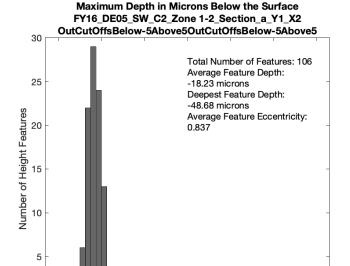
### Pit Depth Y4X15 Histogram Height Data Deepest Pit Ranking: 9





Maximum Feature Depth Below the Surface in Microns
Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

### Pit Depth Y1X2 Histogram Height Data Deepest Pit Ranking: 10



**Height Flagged Features** 

Maximum Feature Depth Below the Surface in Microns
Minimum Feature Pixels = 50, Maximum Feature Pixels = 100000
Maximum Feature Euler # = -50, Maximum Feature Eccentricity = 0.99999

60

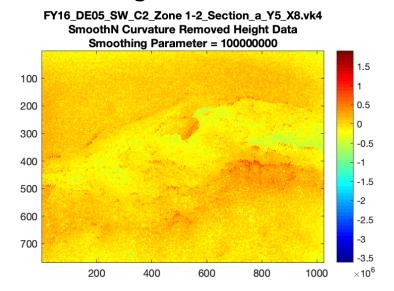
80

100

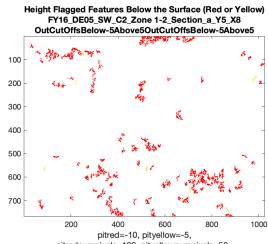
120

### Pit Depth Y5X8 Histogram Height Data Deepest Pit Ranking: 1

#### **Flattened Height Data**



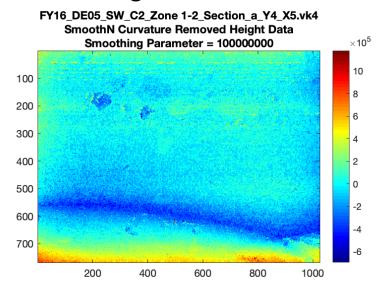
#### **Flagged Height Features**



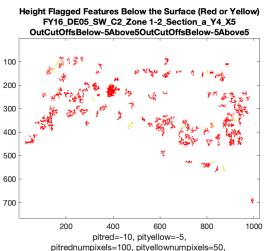
pitrednumpixels=100, pityellownumpixels=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityrednumpixels=100, eccentricityyellownumpixels=50, smoothparameter=100000000.

### Pit Depth Y4X5 Histogram Height Data Deepest Pit Ranking: 2

#### **Flattened Height Data**



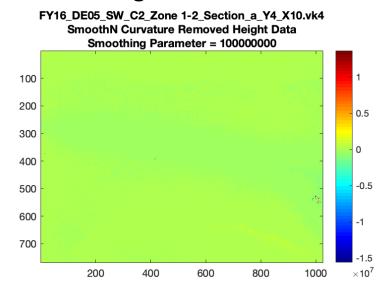
#### **Flagged Height Features**



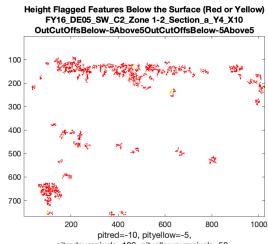
pitrednumpixels=100, pityellownumpixels=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityrednumpixels=100, eccentricityyellownumpixels=50, smoothparameter=100000000.

### Pit Depth Y4X10 Histogram Height Data Deepest Pit Ranking: 3

#### **Flattened Height Data**



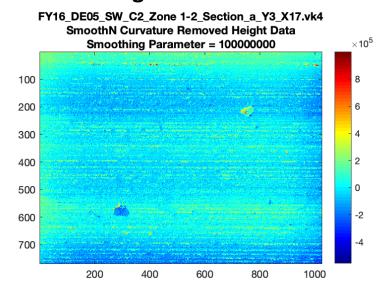
#### **Flagged Height Features**



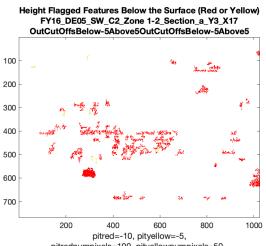
pitrednumpixels=100, pityellownumpixels=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityrednumpixels=100, eccentricityyellownumpixels=50, smoothparameter=100000000.

### Pit Depth Y3X17 Histogram Height Data Deepest Pit Ranking: 4

#### **Flattened Height Data**



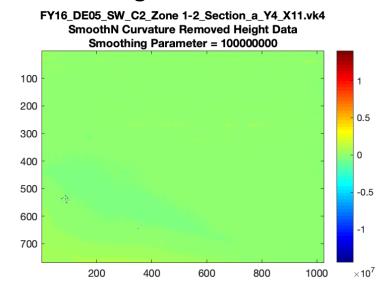
#### **Flagged Height Features**



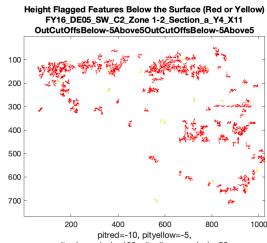
pitrednumpixels=100, pityellownumpixels=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityrednumpixels=100, eccentricityyellownumpixels=50, smoothparameter=100000000.

### Pit Depth Y4X11 Histogram Height Data Deepest Pit Ranking: 5

#### **Flattened Height Data**



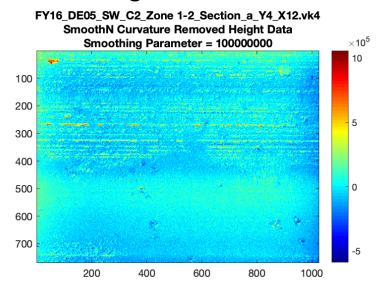
#### **Flagged Height Features**



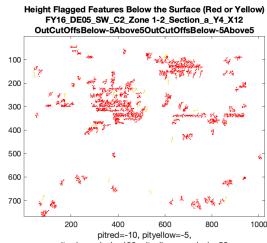
pitrednumpixels=100, pityellownumpixels=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityrednumpixels=100, eccentricityyellownumpixels=50, smoothparameter=100000000.

### Pit Depth Y4X12 Histogram Height Data Deepest Pit Ranking: 6

#### **Flattened Height Data**



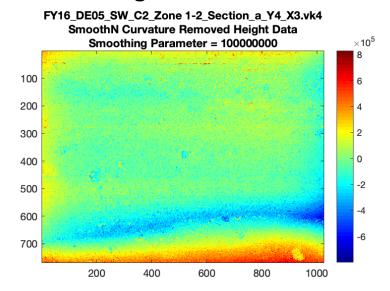
#### **Flagged Height Features**



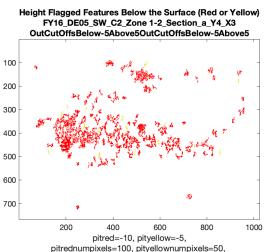
pitrednumpixels=100, pityellownumpixels=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityrednumpixels=100, eccentricityyellownumpixels=50, smoothparameter=100000000.

### Pit Depth Y4X3 Histogram Height Data Deepest Pit Ranking: 7

#### **Flattened Height Data**



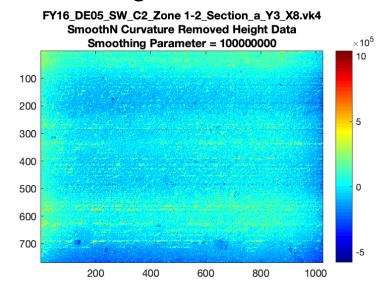
#### **Flagged Height Features**



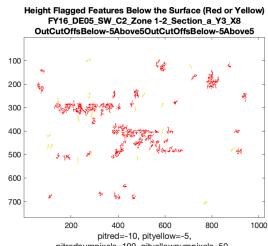
pitreanumpixeis=100, pityeilownumpixeis=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityrednumpixels=100, eccentricityyellownumpixels=50, smoothparameter=100000000.

### Pit Depth Y3X8 Histogram Height Data Deepest Pit Ranking: 8

#### **Flattened Height Data**



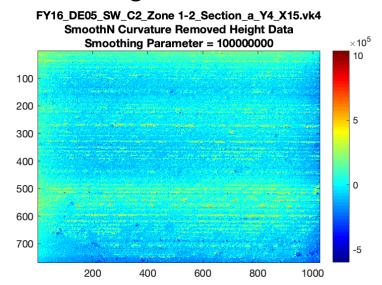
#### **Flagged Height Features**



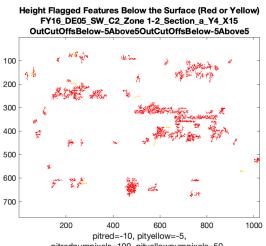
pitrednumpixels=100, pityellownumpixels=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityyellownumpixels=50, eccentricityyellownumpixels=50, smoothparameter=100000000.

### Pit Depth Y4X15 Histogram Height Data Deepest Pit Ranking: 9

#### **Flattened Height Data**



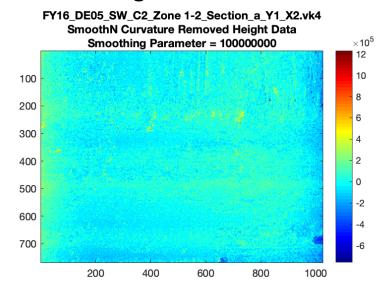
#### **Flagged Height Features**



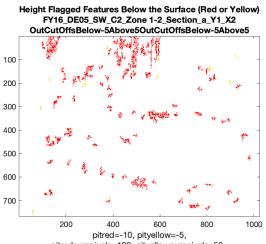
pitrednumpixels=100, pityellownumpixels=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityrednumpixels=100, eccentricityyellownumpixels=50, smoothparameter=100000000.

### Pit Depth Y1X2 Histogram Height Data Deepest Pit Ranking: 10

#### **Flattened Height Data**

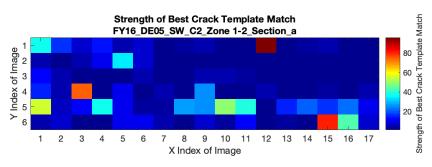


#### **Flagged Height Features**



pitrednumpixels=100, pityellownumpixels=50, eccentricityred=0.995,eccentricityyellow=0.98, eccentricityrednumpixels=100, eccentricityyellownumpixels=50, smoothparameter=100000000.

## Crack Strength YX Index Key All Images: FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a\_cTOP10 Intensity Data



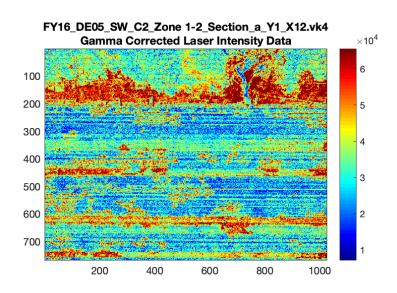
Amplitudes: 0 6 9, Periods: 0.07 0.09
Orientations: 0, 3, ..., 357, Phase Shifts: 0
startt: 0, stepst: 200, finishts: 100 200
linewidth: 10, bufferwidth: 2, stencillinewidth: 15
stencilweight: 2, bufferweight: 0
intensitylimitquantilecutoff: 0.3, maskpower: 0.5
maskmaximumpixelsize: 1000, maskmethodology: 1

### Crack Strength of Image Y1X12, Intensity Data Strongest All Image Ranking: 1, Strength: 96

#### **Crack Template Matches (black dots)**

# 

#### **Original Intensity Data (different scale)**

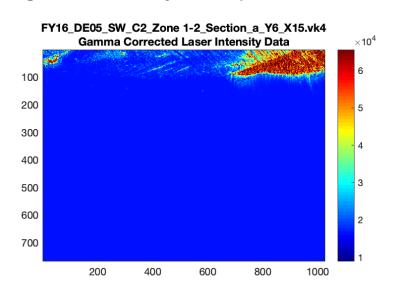


### Crack Strength of Image Y6X15, Intensity Data Strongest All Image Ranking: 2, Strength: 81

#### **Crack Template Matches (black dots)**

## 

#### **Original Intensity Data (different scale)**

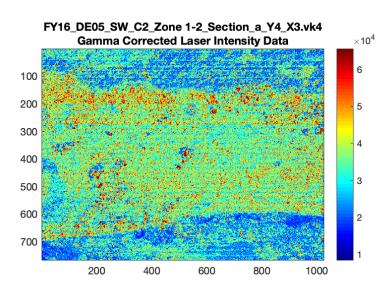


### Crack Strength of Image Y4X3, Intensity Data Strongest All Image Ranking: 3, Strength: 74

#### **Crack Template Matches (black dots)**

# Strength = 74 Out of 1440 Total Votes Highest strength in each parameter set than rathless the crack template is represented by a black dot strength in each parameter set than 1440 these the crack template is represented by a black dot strength in each parameter set than 1440 these the crack template is represented by a black dot strength in each parameter set than 1440 these the crack templates and the strength in each parameter set than 1440 the strength in each p

#### **Original Intensity Data (different scale)**

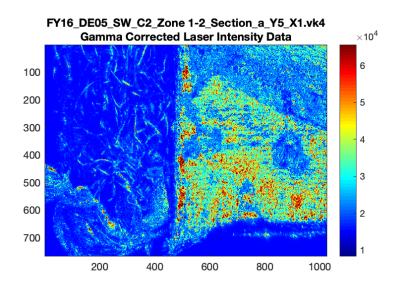


### Crack Strength of Image Y5X1, Intensity Data Strongest All Image Ranking: 4, Strength: 55

#### **Crack Template Matches (black dots)**

Ampittudes: U o y, Perdods: UU U UU Orientations: 0, 3, ..., 357, Phase Shifts: 0 start: 0, stepst: 200, finishts: 100 200 linewidth: 10, bufferwidth: 2, stencillinewidth: 15 stencillweight: 2, bufferweight: 0, intensitylimitquantillecutoff: 0.3, maskpower: 0.5 stencillweight: 2, bufferweight: 0, intensitylimitquantillecutoff: 0.3, maskpower: 0.5

#### **Original Intensity Data (different scale)**

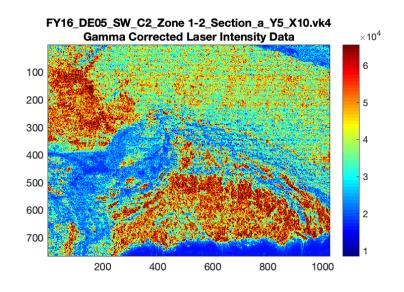


### Crack Strength of Image Y5X10, Intensity Data Strongest All Image Ranking: 5, Strength: 49

#### **Crack Template Matches (black dots)**

# 

#### **Original Intensity Data (different scale)**

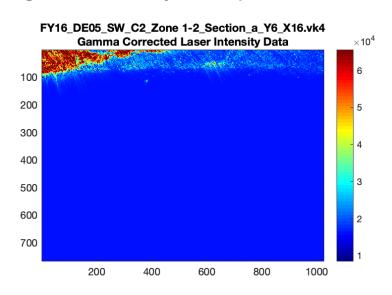


### Crack Strength of Image Y6X16, Intensity Data Strongest All Image Ranking: 6, Strength: 44

#### **Crack Template Matches (black dots)**

## 

#### **Original Intensity Data (different scale)**

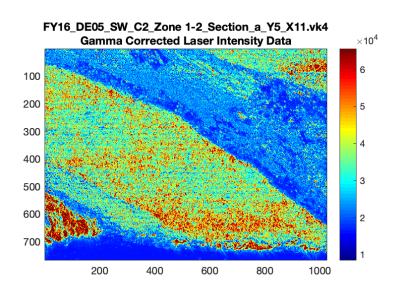


### Crack Strength of Image Y5X11, Intensity Data Strongest All Image Ranking: 7, Strength: 39

#### **Crack Template Matches (black dots)**

# Strength = 39 Out of 1440 Total Votes Highest strength in each pstrength in each pstrength and circle area matches the red crack template Highest strength in each pstrength in each pstrength and circle area matches the red crack template Highest strength in each pstrength and circle area matches the red crack template Highest strength in each pstrength and circle area matches the red crack template Period = 0.07, Amplitude = 0, Orientation = 16, finisht = 100 200 200 200 Amplitudes = 0, Orientation = 16, finisht = 100 200 Amplitudes = 0, Orientation = 0, orientation = 16, finisht = 100 200 Amplitudes = 0, orientation = 0, orientation = 16, finisht = 100 200 Amplitudes = 0, orientation = 0, orient

#### **Original Intensity Data (different scale)**

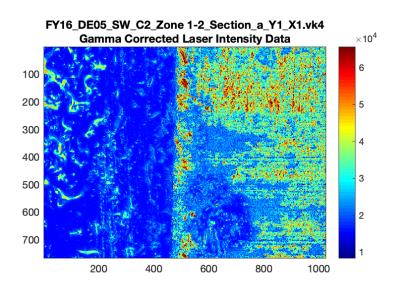


# Crack Strength of Image Y1X1, Intensity Data Strongest All Image Ranking: 8, Strength: 38

#### **Crack Template Matches (black dots)**

# 

#### **Original Intensity Data (different scale)**

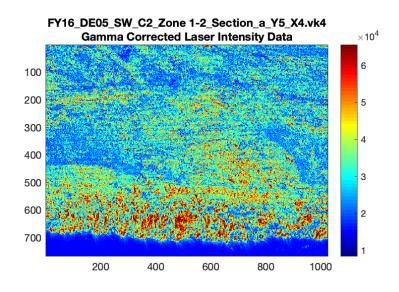


# Crack Strength of Image Y5X4, Intensity Data Strongest All Image Ranking: 9, Strength: 37

#### **Crack Template Matches (black dots)**

# 

#### **Original Intensity Data (different scale)**

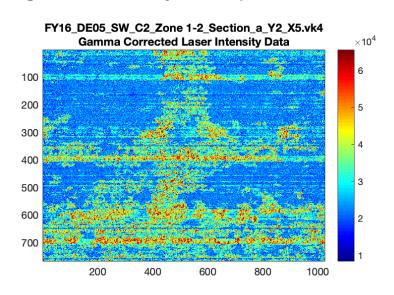


# Crack Strength of Image Y2X5, Intensity Data Strongest All Image Ranking: 10, Strength: 34

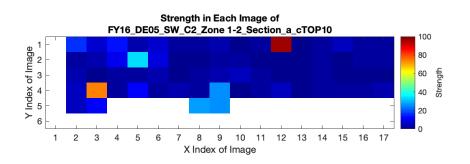
#### **Crack Template Matches (black dots)**

# Strength = 34 Out of 1440 Total Votes Highest strength in each strength in each active man matches the red crack template Highest strength in each part of circle area matches the red crack template Highest strength in each part of the circle area matches the red crack template Highest strength in each part of the circle area matches the red crack template Period = 0.07, Amplitude = 0, Orientation = 357, finisht = 100 200 100 200 100 200 100 200 100 200 100 200 100 200 100 200 100

#### **Original Intensity Data (different scale)**



# Crack Strength YX Index Key Select Images: FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a\_cTOP10 Intensity Data

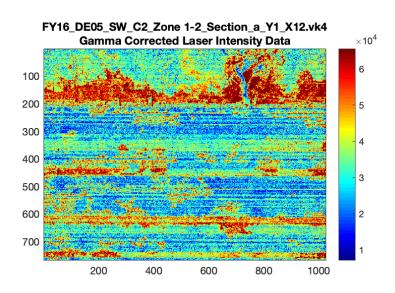


## Crack Strength of Image Y1X12, Intensity Data Strongest Select Image Ranking: 1, Strength: 96

#### **Crack Template Matches (black dots)**

# Strongth - 98 Out of 1440 Total Votes Highest strength in red circle area matches the red crack template is represented by a black dot Fifs Ed. Ser. 2. Zone 1-2. Section, a. Yl. X12 Period = 0.07, Amplitude = 0, Orientation = 60, finisht = 100 100 100 100 100 100 200 300 400 600 700 300 400 Column Number, Amplitudes 0 6, Periods 0.07 0.00 Column Number, Amplitudes 0 6, Periods 0.07 0.00 Column Number, Stendille Service Column

#### **Original Intensity Data (different scale)**

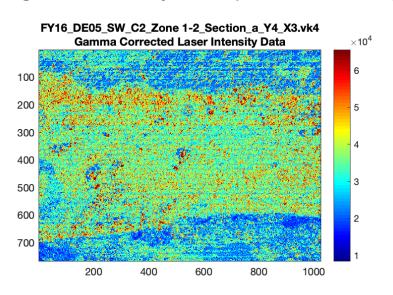


## Crack Strength of Image Y4X3, Intensity Data Strongest Select Image Ranking: 2, Strength: 74

#### **Crack Template Matches (black dots)**

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#### **Original Intensity Data (different scale)**

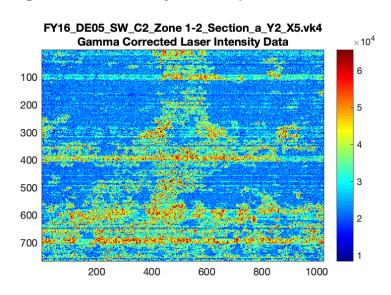


## Crack Strength of Image Y2X5, Intensity Data Strongest Select Image Ranking: 3, Strength: 34

#### **Crack Template Matches (black dots)**

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#### **Original Intensity Data (different scale)**

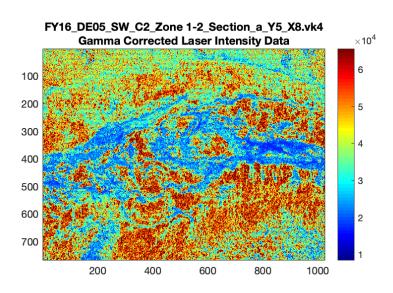


## Crack Strength of Image Y5X8, Intensity Data Strongest Select Image Ranking: 4, Strength: 27

#### **Crack Template Matches (black dots)**

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#### **Original Intensity Data (different scale)**

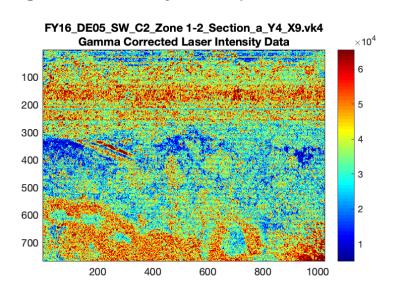


## Crack Strength of Image Y4X9, Intensity Data Strongest Select Image Ranking: 5, Strength: 26

#### **Crack Template Matches (black dots)**

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#### **Original Intensity Data (different scale)**

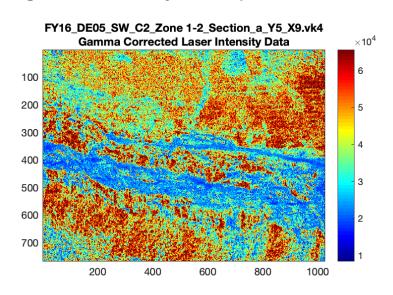


## Crack Strength of Image Y5X9, Intensity Data Strongest Select Image Ranking: 6, Strength: 25

#### **Crack Template Matches (black dots)**

# Strongth - 25 Out of 1440 Total Votes Highest strength in red orice area matches the red crack template is represented by a black dot reference are that matches the crack template is represented by a black dot reference and red to re

#### **Original Intensity Data (different scale)**

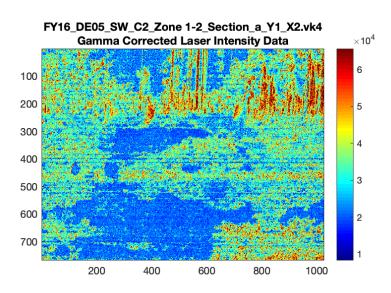


## Crack Strength of Image Y1X2, Intensity Data Strongest Select Image Ranking: 7, Strength: 16

#### **Crack Template Matches (black dots)**

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#### **Original Intensity Data (different scale)**

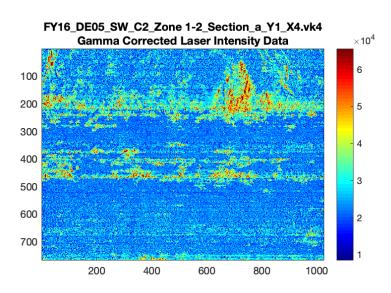


## Crack Strength of Image Y1X4, Intensity Data Strongest Select Image Ranking: 8, Strength: 14

#### **Crack Template Matches (black dots)**

# Strength = 14 Out of 1440 Total Votes Highest strength in each parameter set than rathers the roak cannot be supported by a black dot strength in each parameter set than rathers the crask template in represented by a black dot period = 0.07, Amplitude = 0, Orientation = 316, finisht = 100 Period = 0.07, Amplitude = 0, Orientation = 316, finisht = 100 100 200 Amplitude = 0, Orientation = 316, finisht = 100 Amplitude = 0, Orientation = 0, O

#### **Original Intensity Data (different scale)**

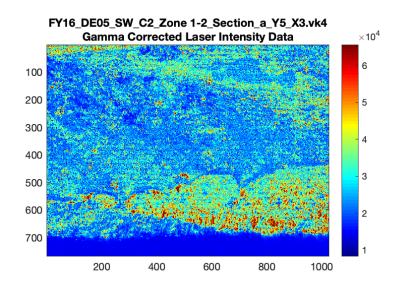


## Crack Strength of Image Y5X3, Intensity Data Strongest Select Image Ranking: 9, Strength: 12

#### **Crack Template Matches (black dots)**

# Strength = 12 Out of 1440 Total Votes Highest strength in each parameter set than rathless the crack template is represented by a black dot strength in each parameter set than that which the Care Manufacture is represented by a black dot strength in each parameter set than 1640 the strengt

#### **Original Intensity Data (different scale)**

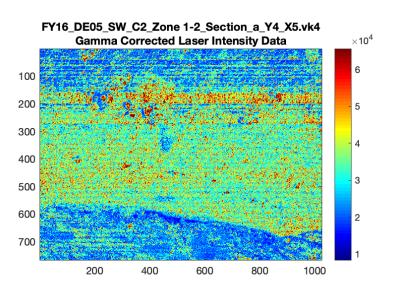


## Crack Strength of Image Y4X5, Intensity Data Strongest Select Image Ranking: 10, Strength: 11

#### **Crack Template Matches (black dots)**

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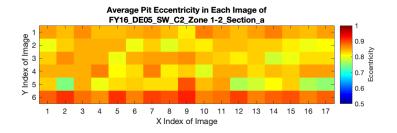
#### **Original Intensity Data (different scale)**

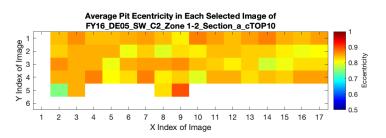


### Average Pit Eccentricity YX Key: Height Data FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a\_cTOP10

#### All Images

#### **Selected Images**





### Pit Feature Density YX Key: Height Data FY16\_DE05\_SW\_C2\_Zone 1-2\_Section\_a\_cTOP10

#### All Images

#### **Selected Images**

